Brumby Flight Dynamics- Instrumentation and Flight Test Results

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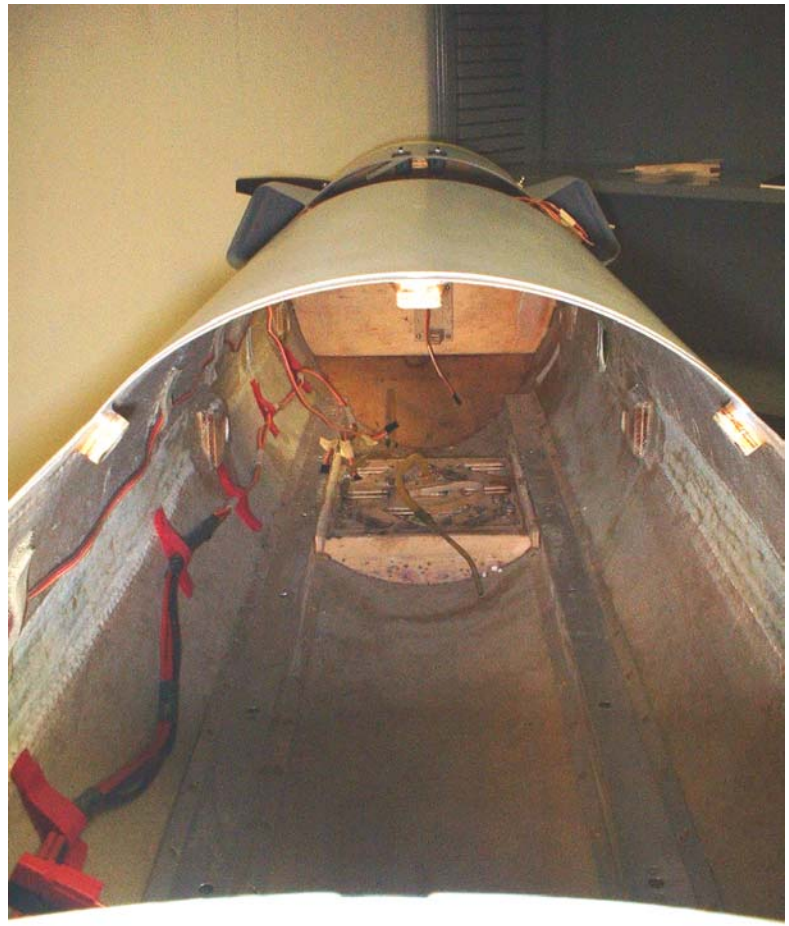
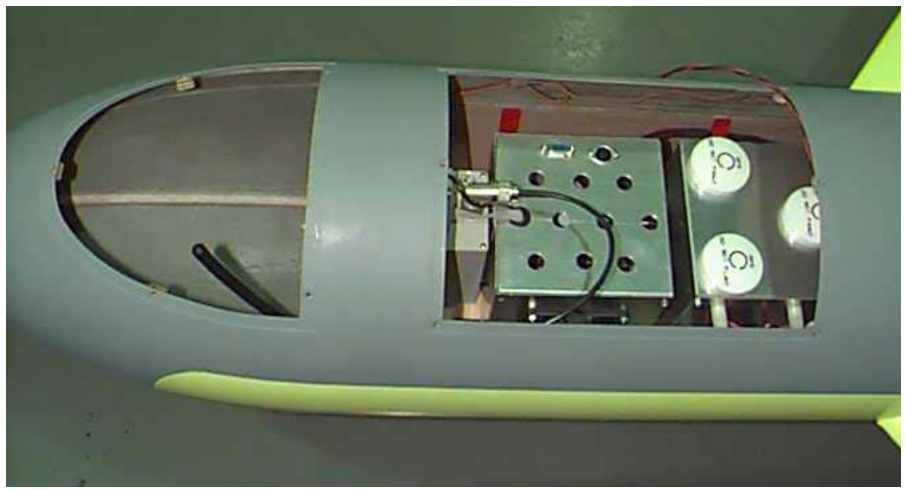
Outline

- Previous Work
  - Triple GPS
  - Airborne Wireless LAN Repeater
- Current Research
  - Sensors
  - Planning
  - Flight Test
  - Results
- Future Work



Previous Work-
Short Base Line
GPS Attitude Determination

- Conducted By Matt Harris and Dr. Dan Aloi
- 3 Marconi Allstar GPS Receiver



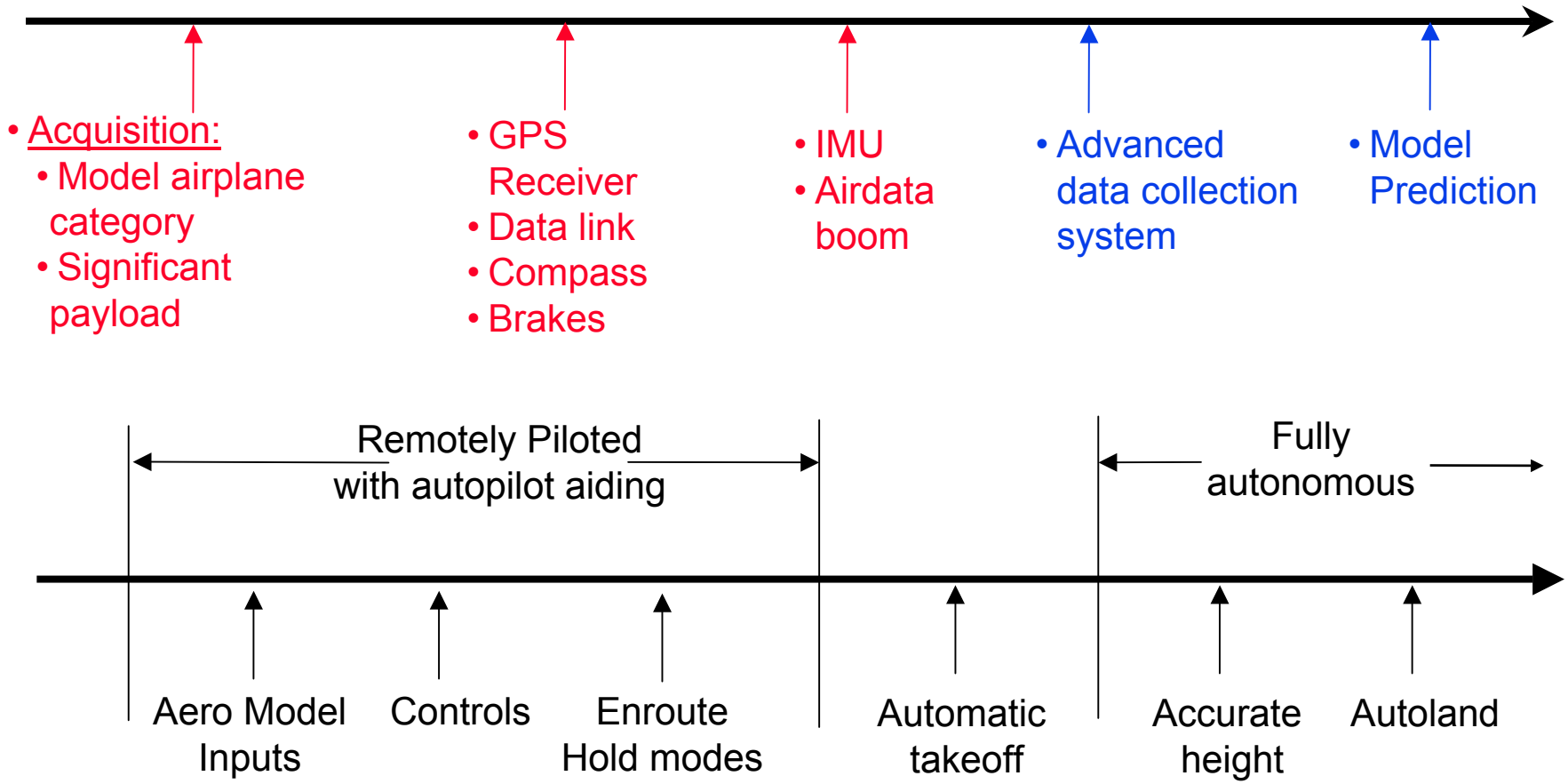
Previous Work-
Airborne Wireless Internet Repeater

Current Research

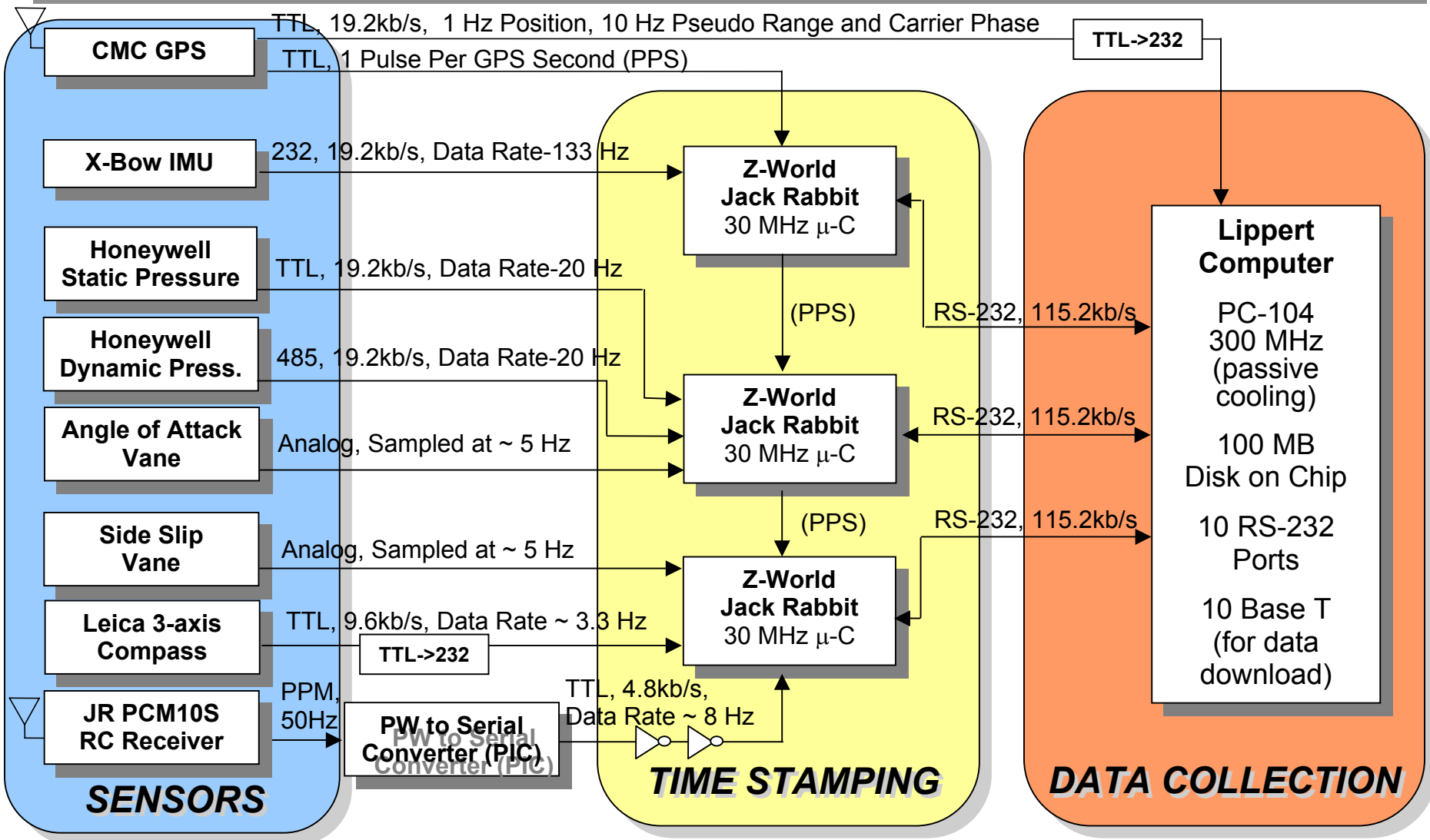
Red - Complete

Blue - In Progress

Black - Future Plans

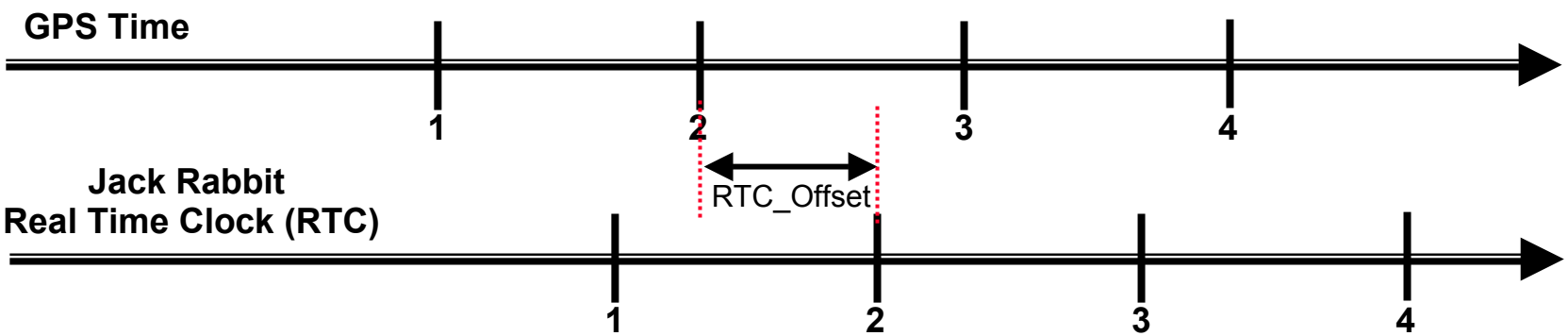


Current Research – Data Wire Diagram



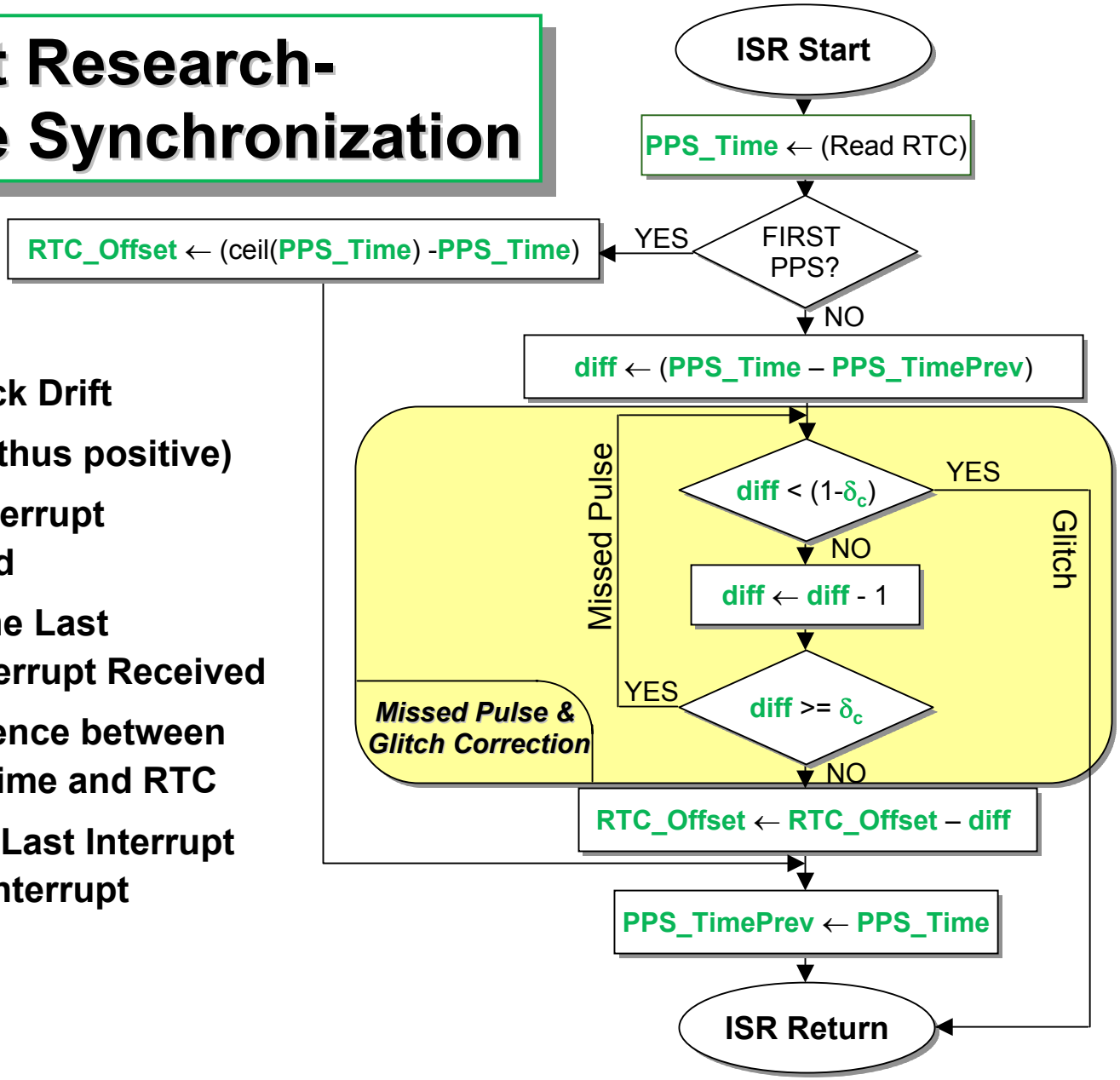
Current Research- μ-C GPS Time Synchronization

- Initialize Jack Rabbit Real Time Clock (RTC) to GPS Time Message
  - GPS Time Message Delayed ~ 0.6 seconds
  - Creates an Offset between GPS Time and the Jack Rabbit's RTC



Current Research- μ-C GPS Time Synchronization

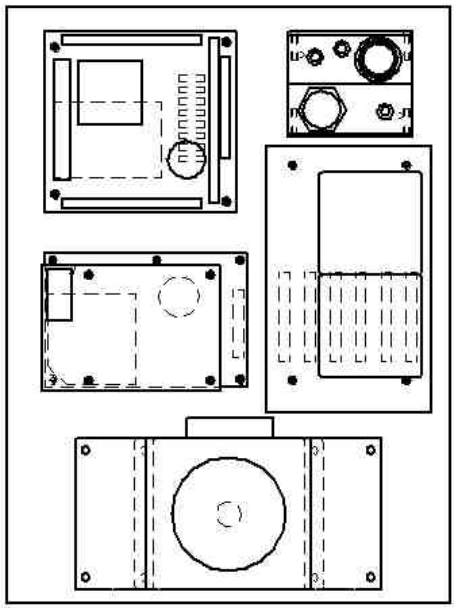
- δ_c: Jack Rabbit Clock Drift (absolute value, thus positive)
- PPS_Time: Time Interrupt Received
- PPS_TimePrev: Time Last Interrupt Received
- RTC_Offset: Difference between GPS Time and RTC
- diff: Time between Last Interrupt and Current Interrupt

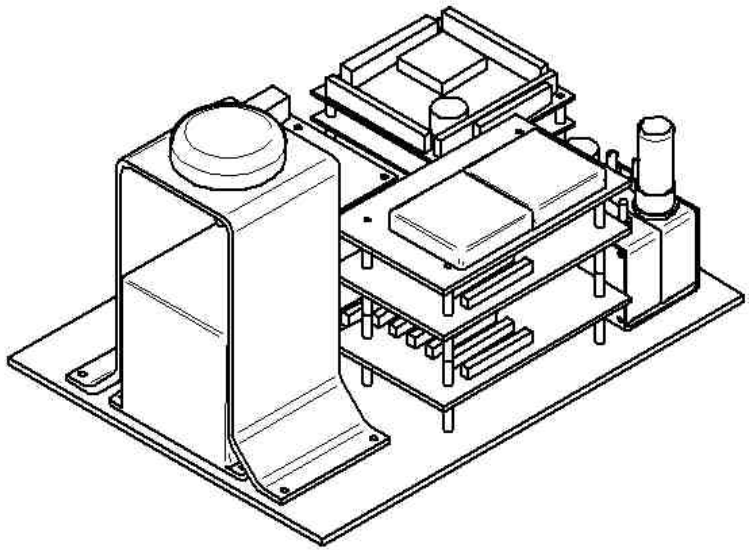


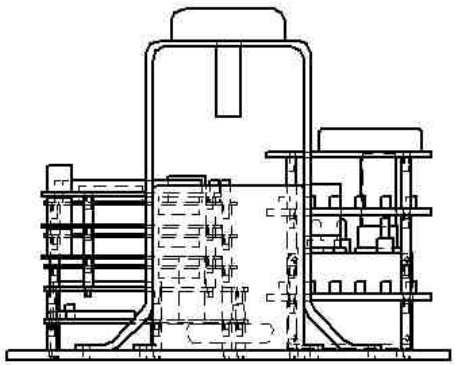
Sensor Measurement Time Stamping Delays

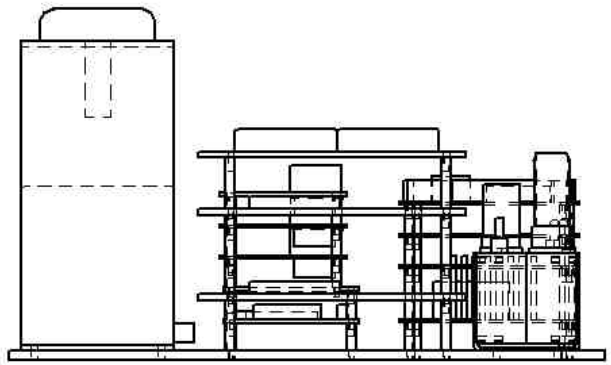
Sensor	Measurement Integration Time (ms)	Sensor Processing Time (ms)	Data Transmission Delay (ms)	Jack Rabbit Time Stamping Delay (ms)	Total Delay (ms)
CMC GPS	0	0	n/a	n/a	0
X-Bow IMU	0.8	0.9	0.260	~0.05	2.01
PPT & HPA (P_d & P_s)	50	16.7	0.521	~0.05	67.2
Alpha & Beta	250	n/a	n/a	~0.05	250
Leica Compass	100	200	1.04	~0.05	301
JR PCM10S RC Receiver	~120	n/a	2.08	~0.05	122

Current Research - Planning

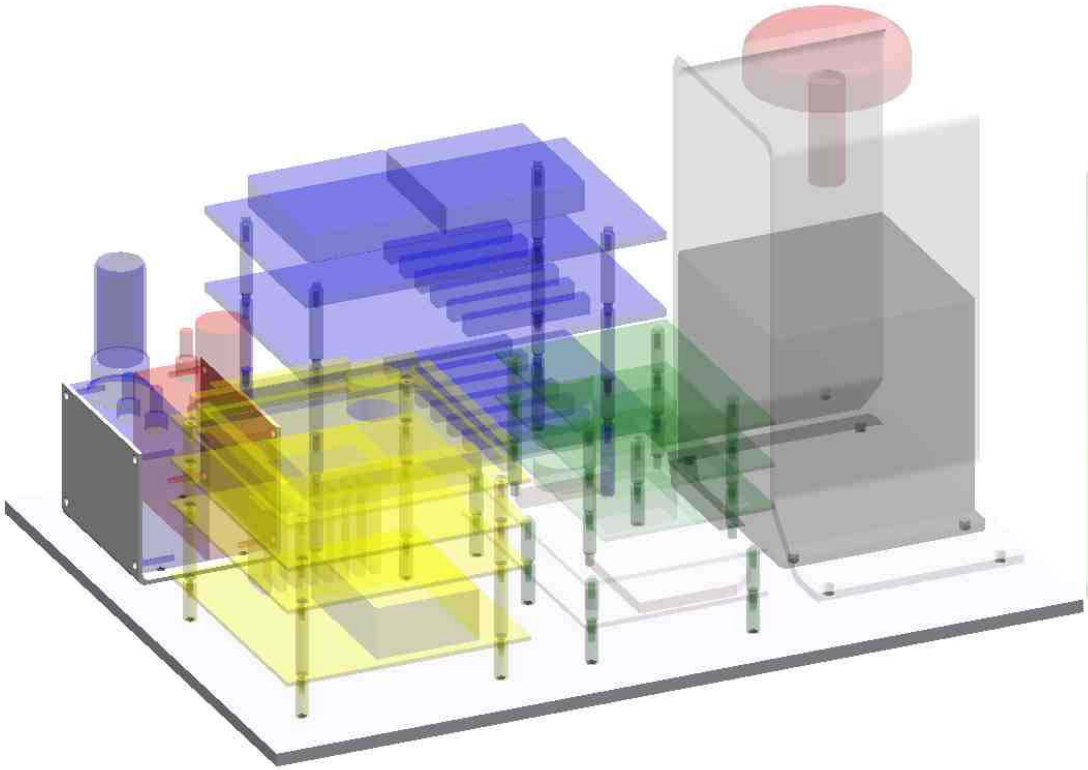




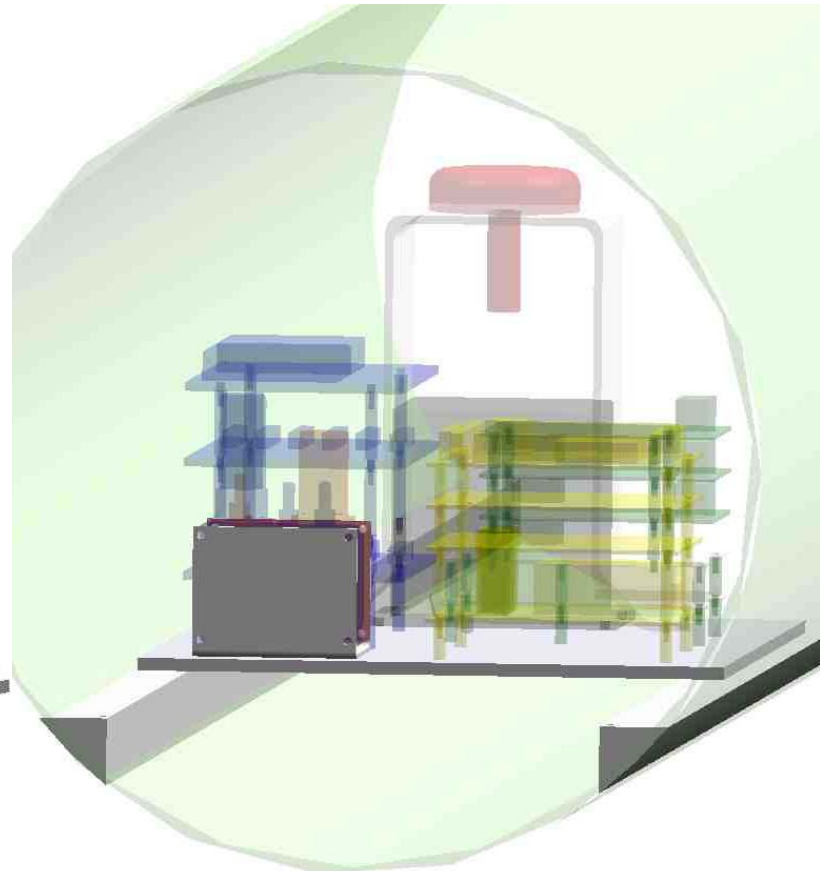




Current Research - Planning



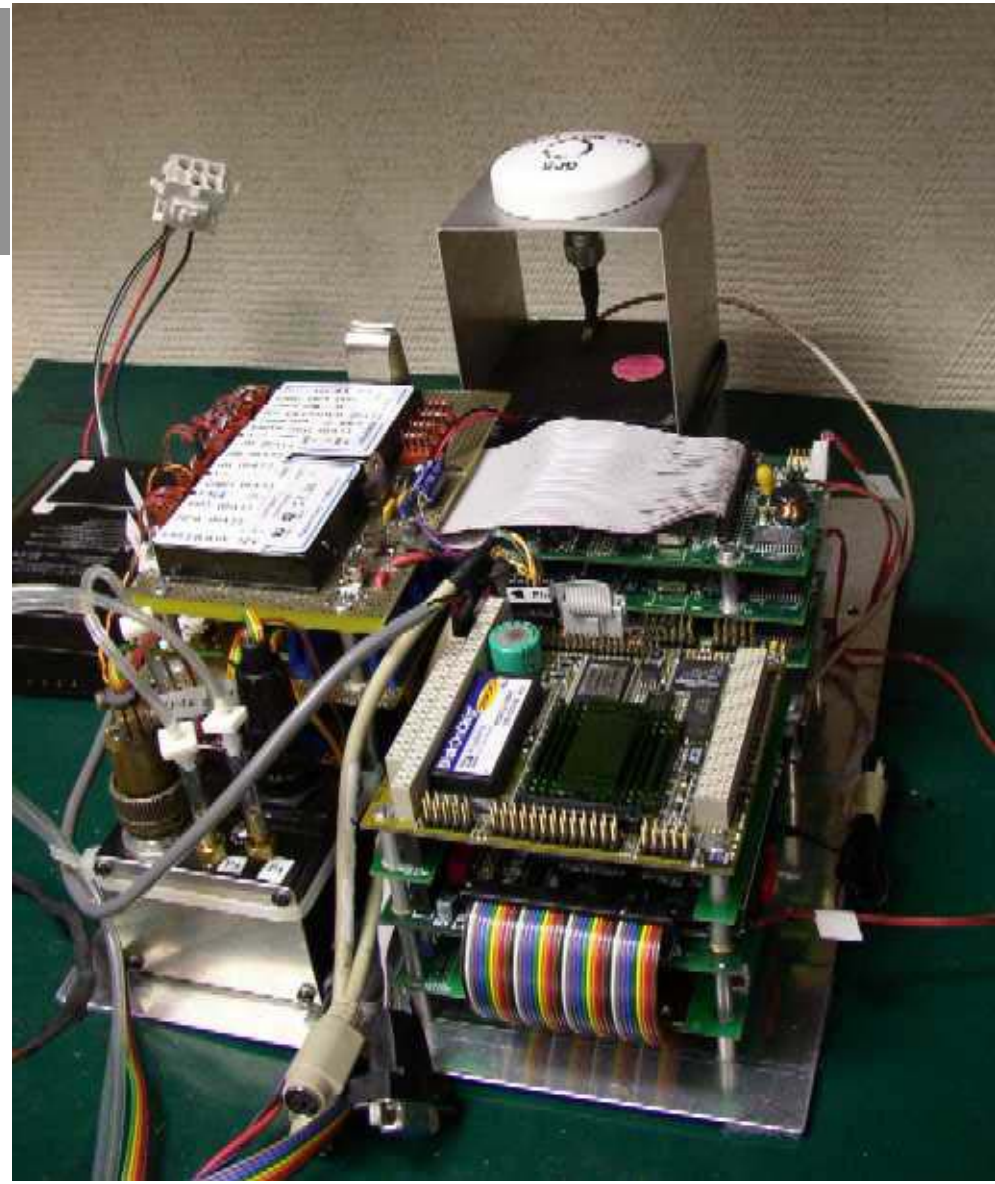
Avionics Platform



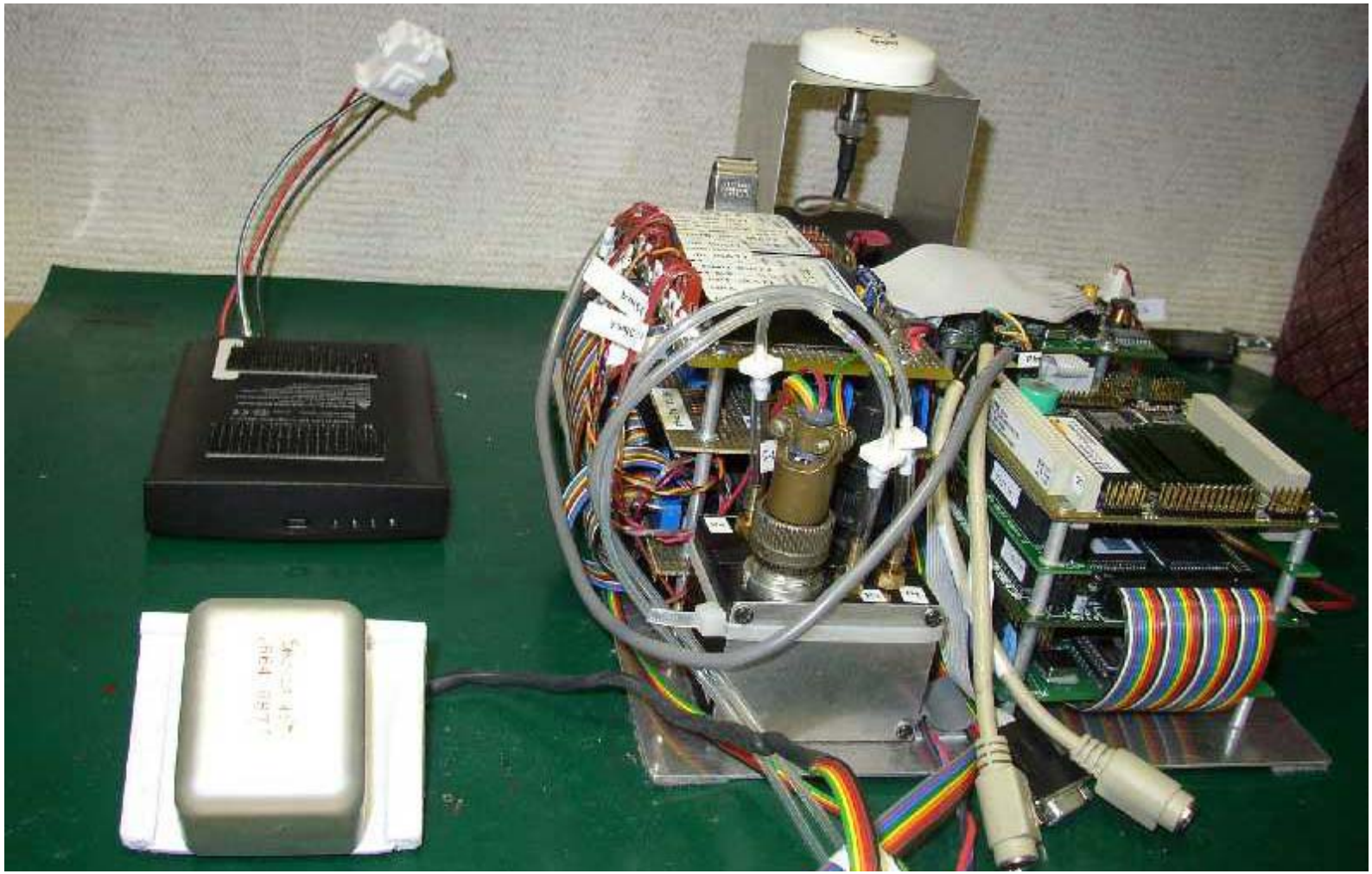
Avionics Platform
with Brumby Hull

Current Research, Flight Test

- Wire Wrap used to allow for flexibility in signal routing
- GPS Antenna Inside Hull



Current Research – Flight Test



Current Research: Power Consumption

- 4 Ah, 14.4 V, Li-Ion Battery (16.4 - 14.0 volts)
  - Measured Load: 1.1 A
  - 3+ hours of Battery Life

Current Research: Weight

Aircraft Weight Budget

Aircraft Empty Weight	37.5 lbs.
Aircraft Weight 10/23/2002 (w/ fuel)	50.25 lbs.
Max Gross Takeoff Weight (AMA* restricted takeoff weight w/ fuel)	55.0 lbs
Max Gross Takeoff Weight (Design Specifications w/o fuel)	66.0 lbs

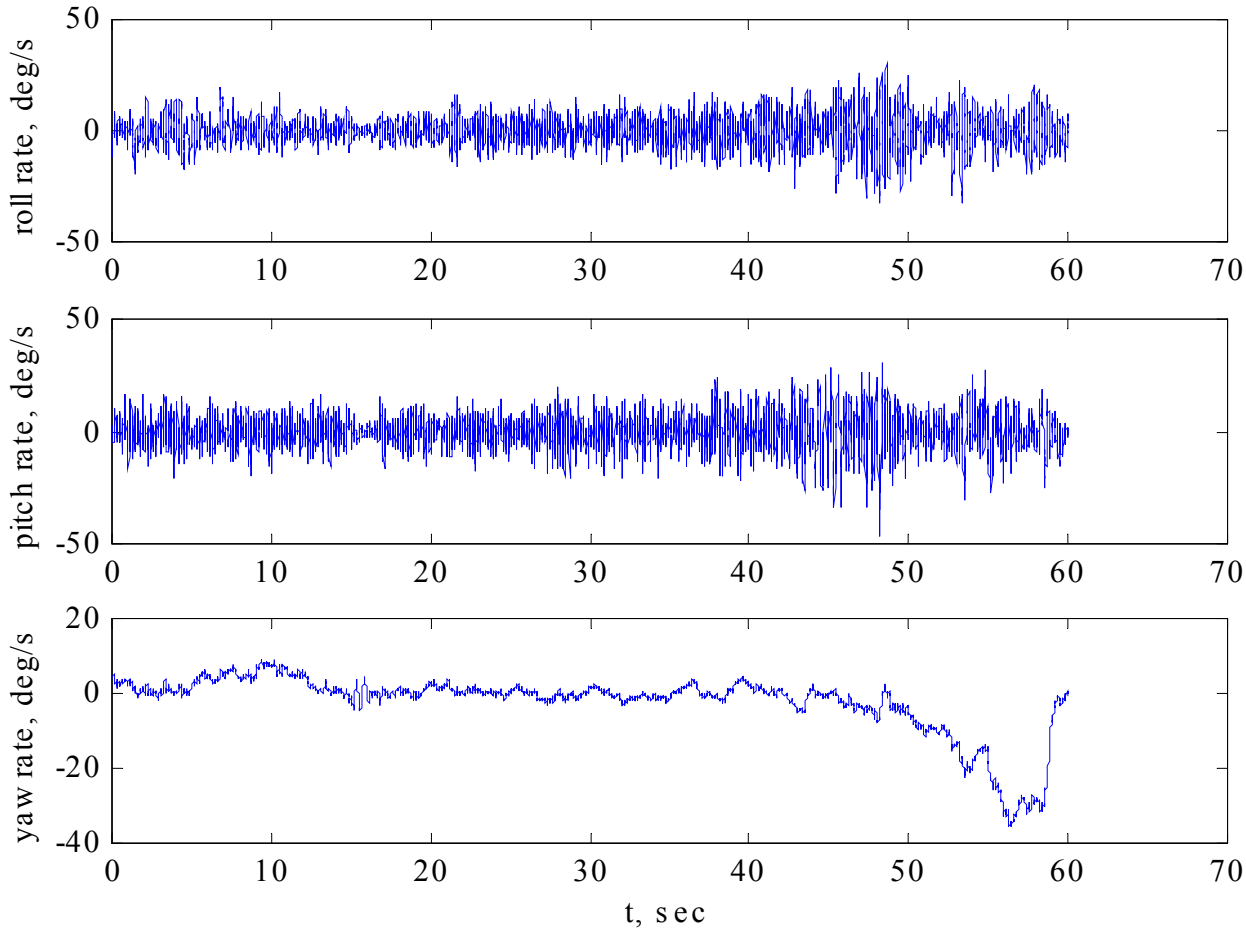
Payload Weight Budget

Device	Weight
Data Collection Panel	6.4 lbs.
Li Ion Battery	1.2 lbs.
Freewave Data Transceiver	1.0 lbs.
Compass	0.2 lbs.
Data Boom	0.4 lbs.
Rx bat. (2, 4-cell Nicad)	2.1 lbs.
Total Payload	**11.3 lbs.**
Available (AMA Legal, w/ fuel)	**4.75 lbs.**

* ACADEMY OF MODEL AERONAUTICS

Flight Test- October 23, 2002

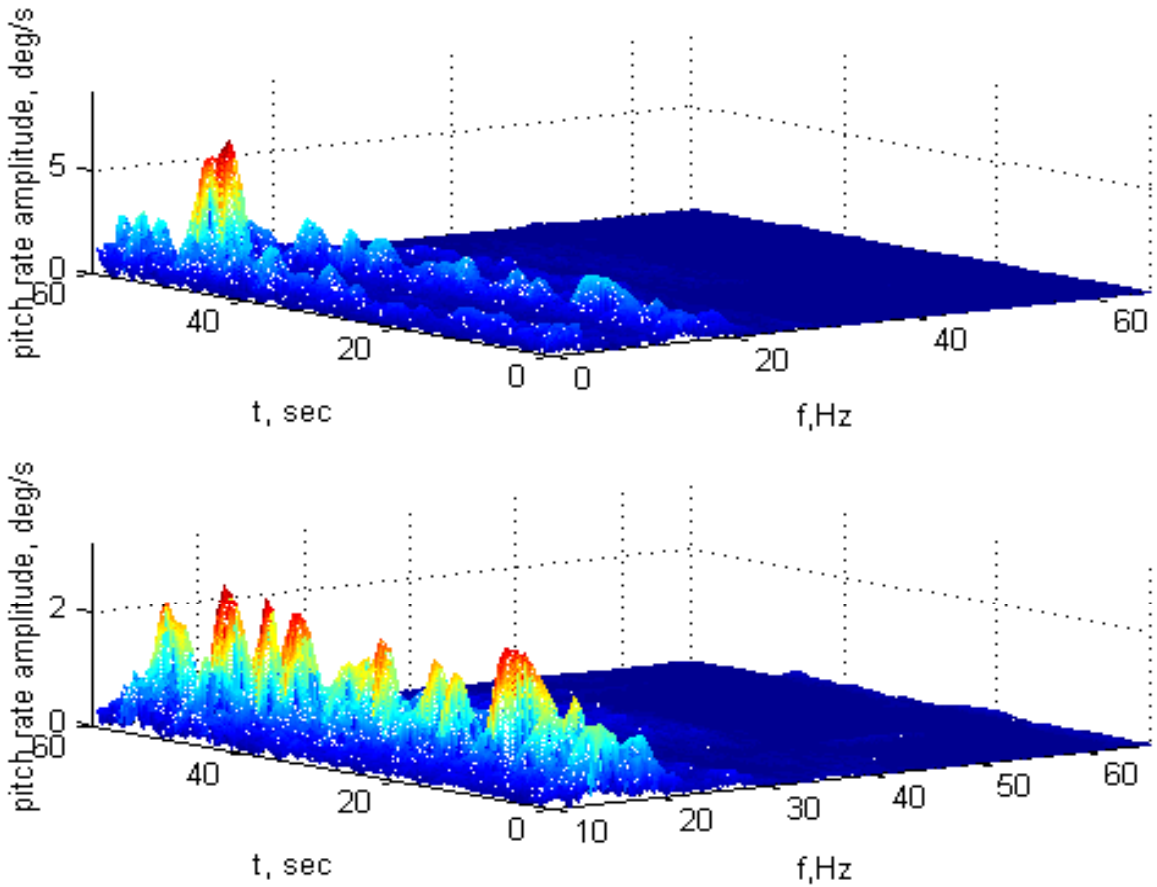
Flight Test – Gyro Outputs



Throttle : 75%
Duration: 60 s

Straight and Level w/ Turn the last 10 Seconds

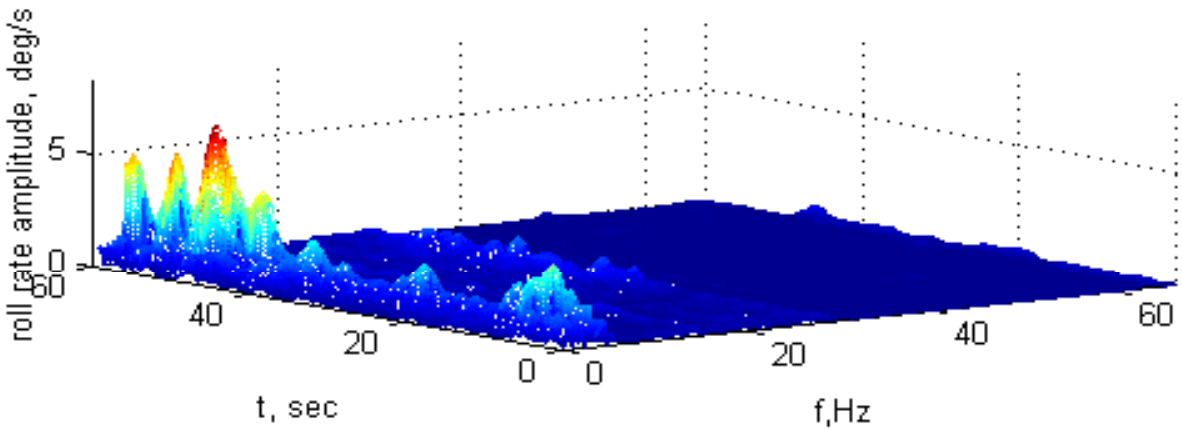
Flight Test – Pitch Gyro

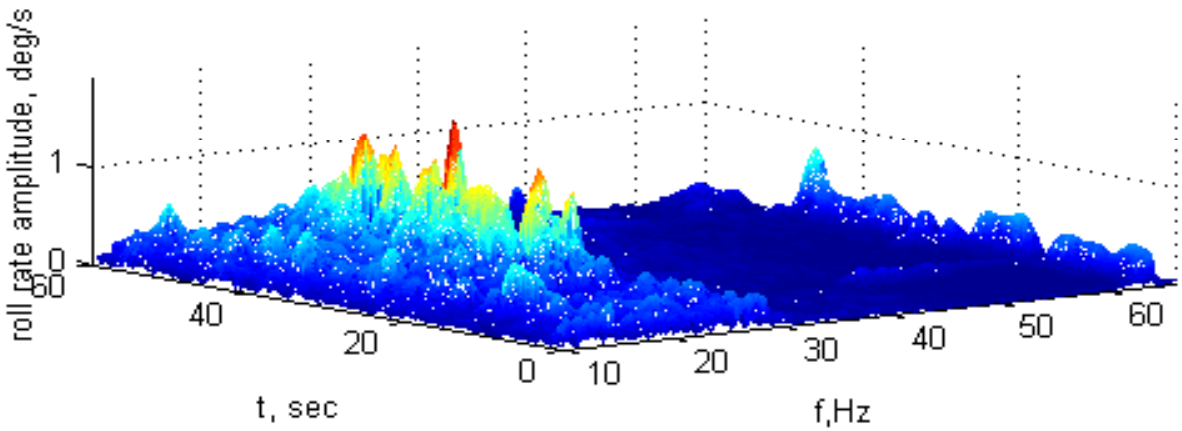


Throttle : 75%
Duration: 60 s

Straight and Level w/ Turn the last 10 Seconds

Flight Test – Roll Gyro

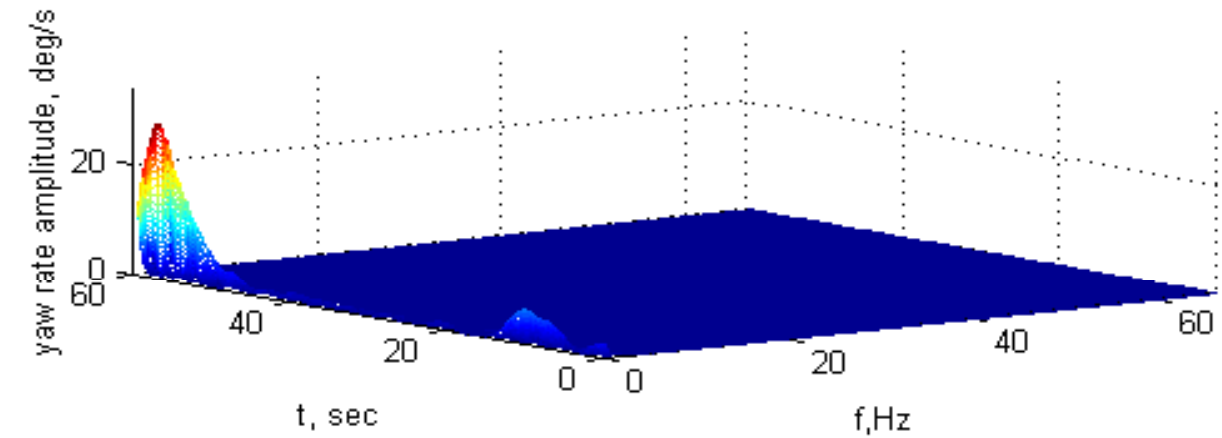


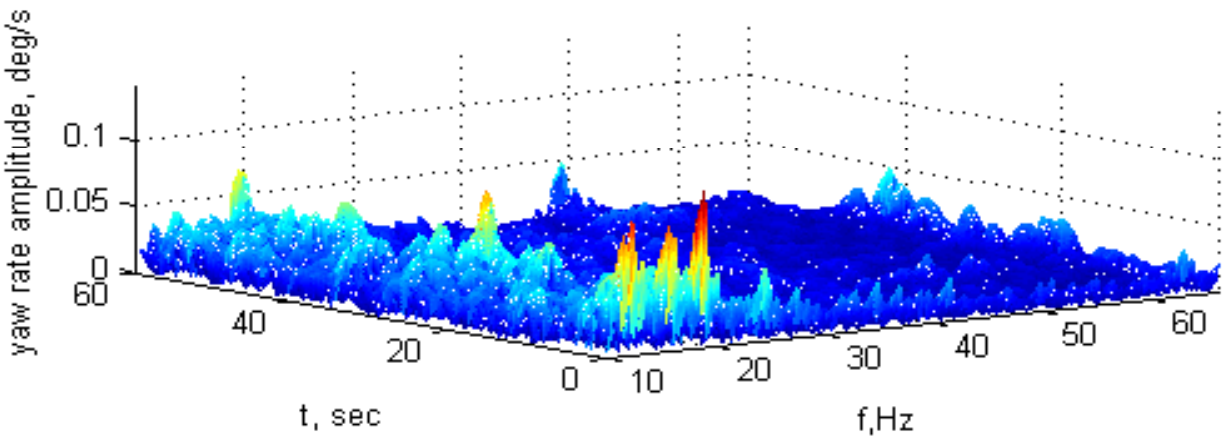


Throttle : 75%
Duration: 60 s

Straight and Level w/ Turn the last 10 Seconds

Flight Test – Yaw Gyro

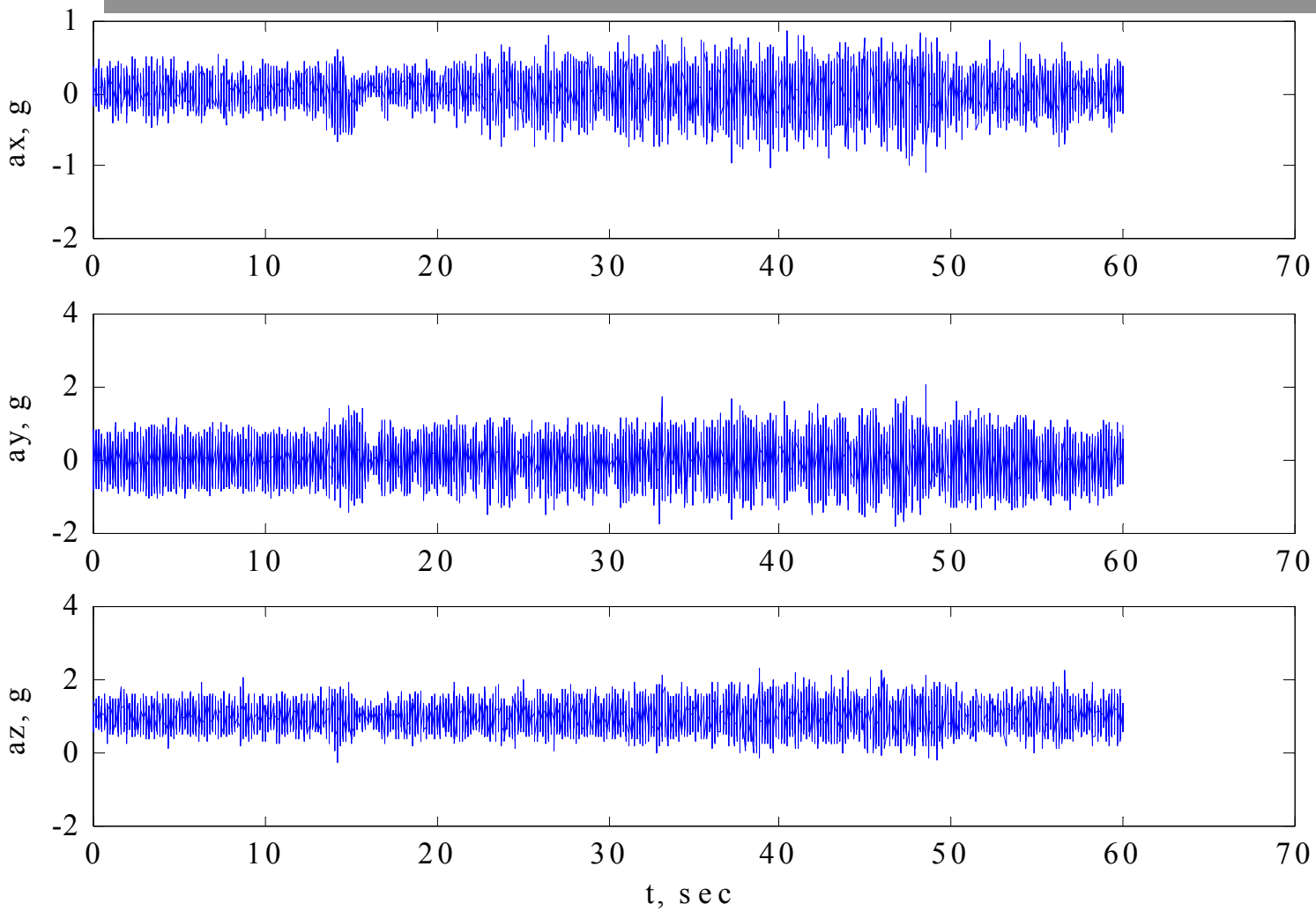




Throttle : 75%
Duration: 60 s

Straight and Level w/ Turn the last 10 Seconds

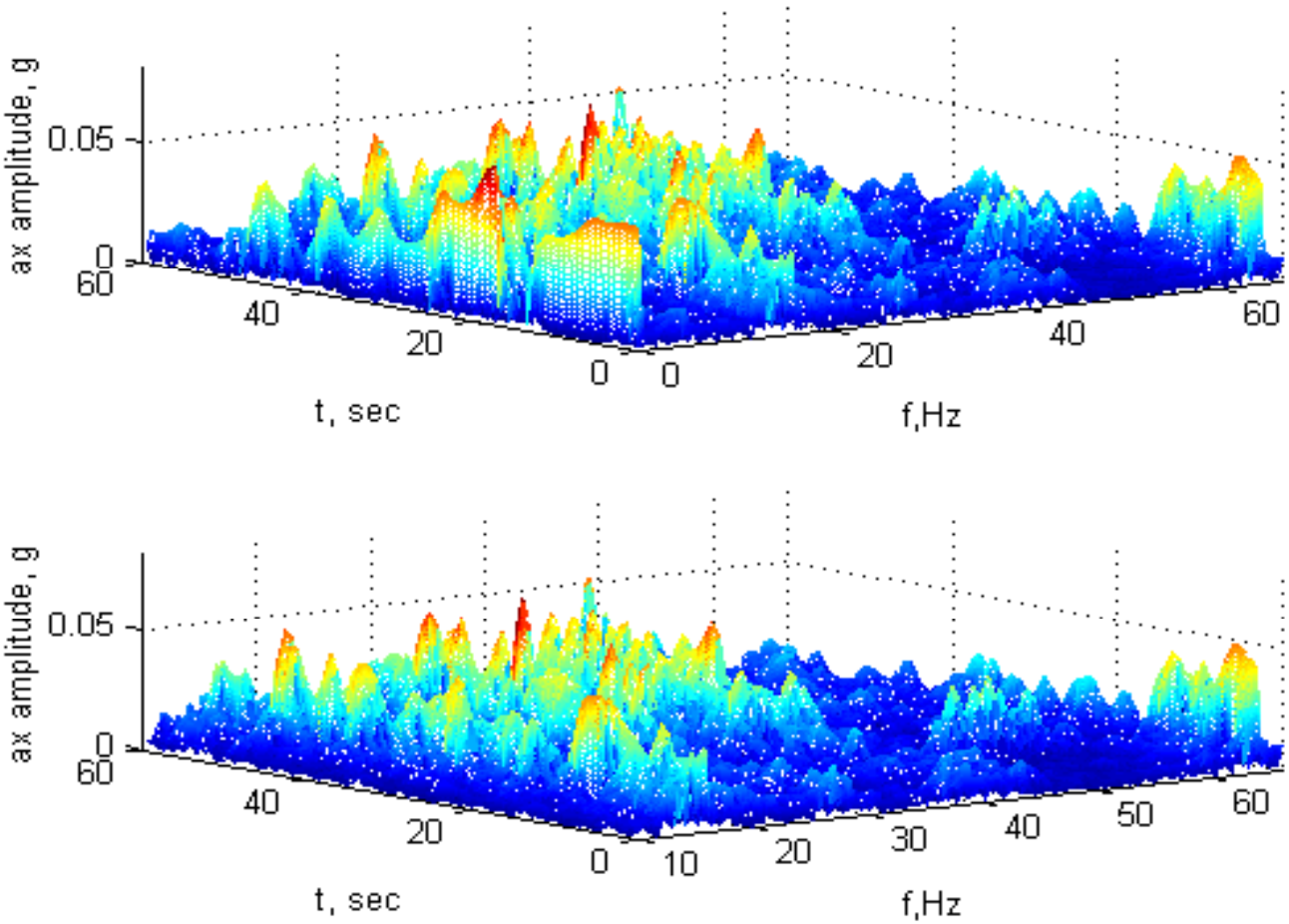
Flight Test – Accelerometer Output



Throttle : 75%
Duration: 60 s

Straight and Level w/ Turn the last 10 Seconds

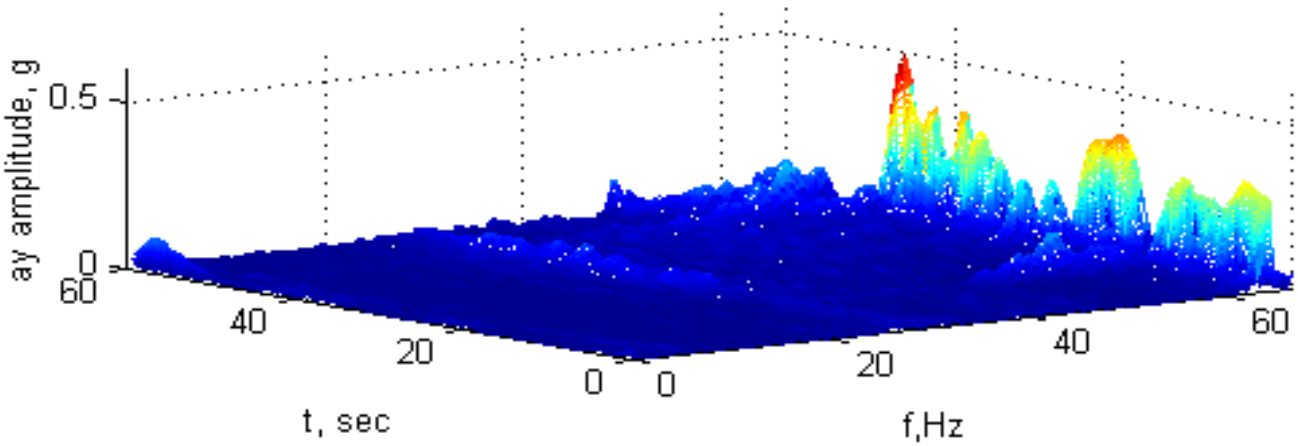
Flight Test – X Accelerometer

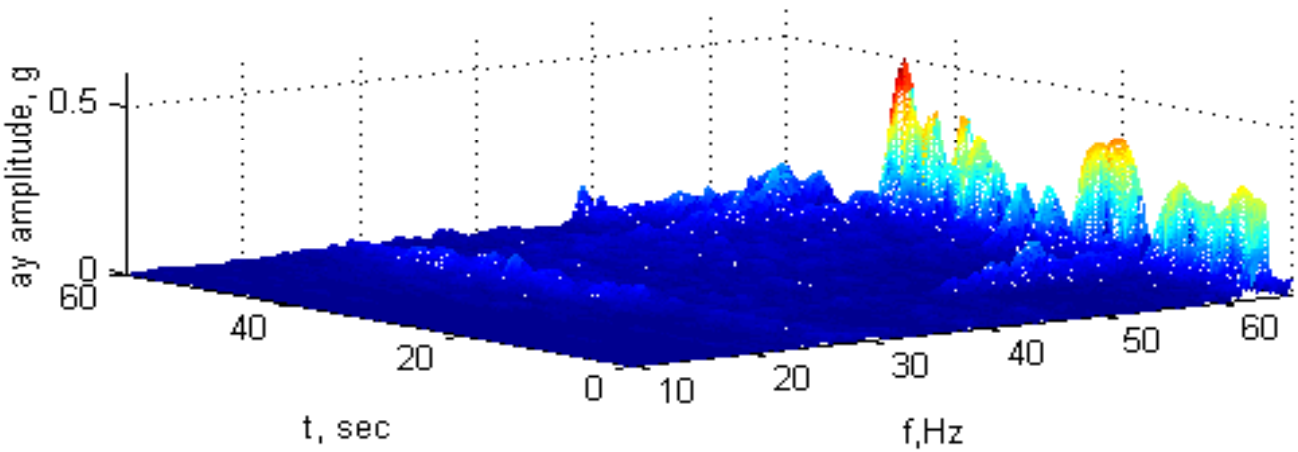


Throttle : 75%
Duration: 60 s

Straight and Level w/ Turn the last 10 Seconds

Flight Test – Y Accelerometer

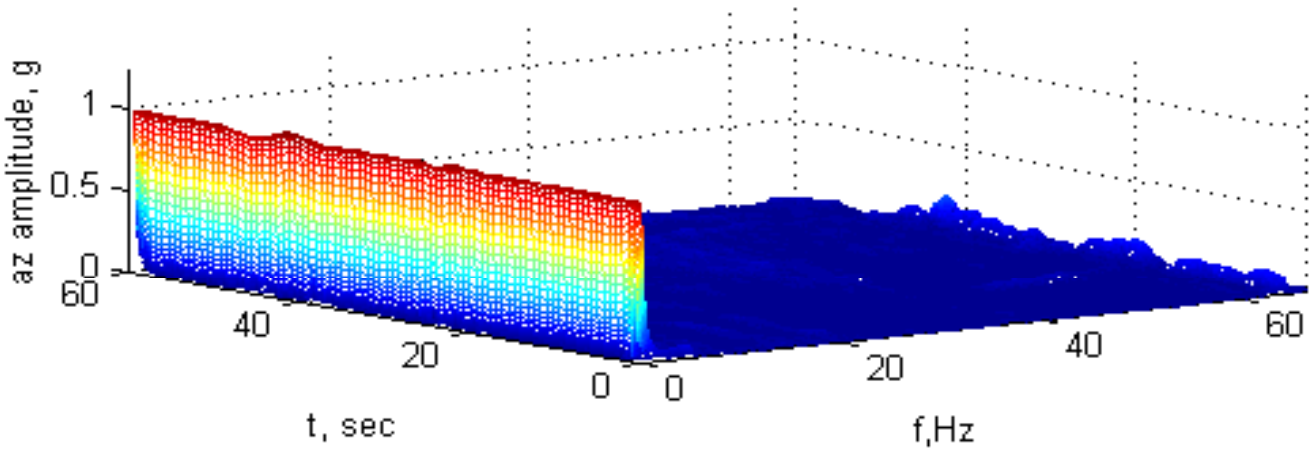


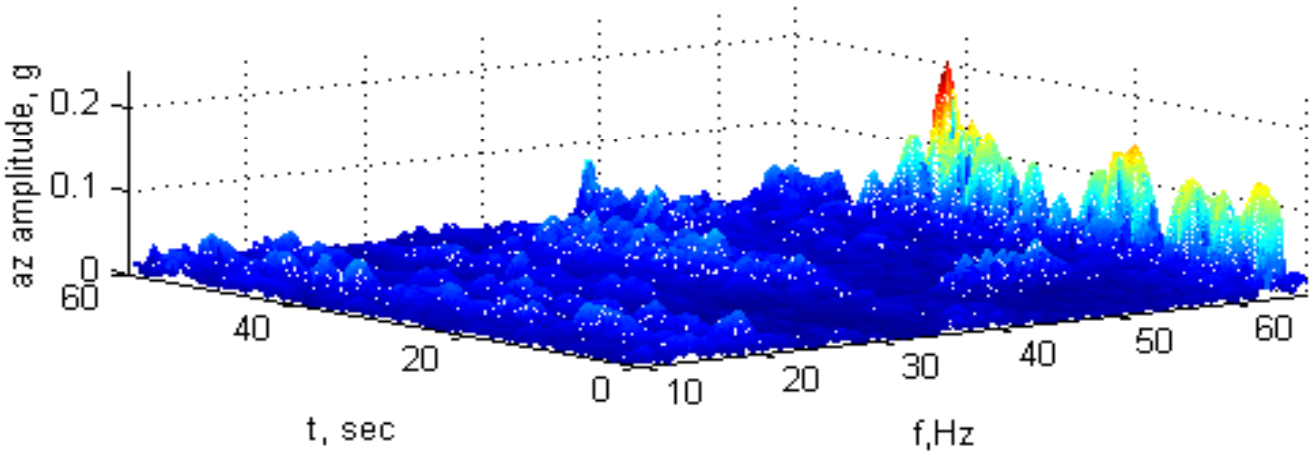


Throttle : 75%
Duration: 60 s

Straight and Level w/ Turn the last 10 Seconds

Flight Test – Z Accelerometer





Throttle : 75%
Duration: 60 s

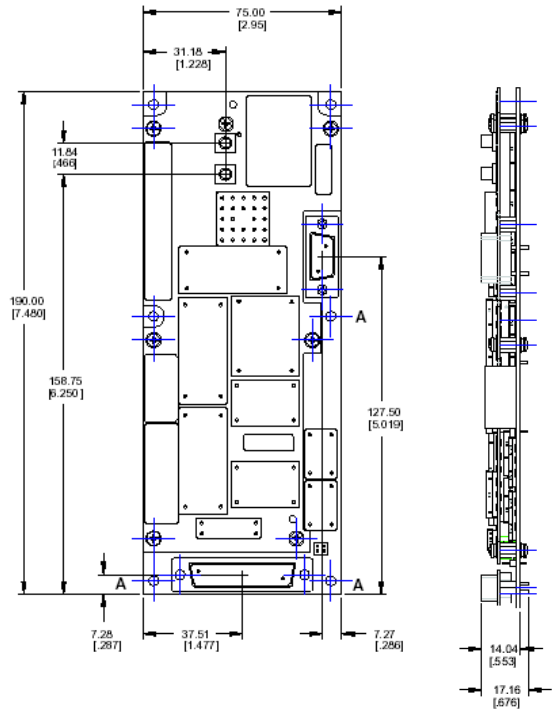
Straight and Level w/ Turn the last 10 Seconds

Future Work

- Data Collection Improvements
  - Increase IMU Time Tagging Precision and Accuracy
    - Second Internal Counter on Jackrabbit
    - IMU Timing Pulse
    - Isolate IMU from Engine "Noise"
  - Add messages to convey the operational state of the JR to the PC-104 and vice-versa.
  - Improve JR subroutine to sample Alpha and Beta
  - Ground Link and Ground Station
- Sean's Work on the 6 DOF Model
- Add a Truth Reference for Multipath Studies
- Satellite Link
  - QUALCOMM Globalstar GSP-1620 Satellite Data Modem (see next slide)

Future Work

- **QUALCOMM Globalstar GSP-1620 Satellite Data Modem**
  - **Power Consumption: 5.4 W max**
  - **Voltage: 5.6-16 VDC**
  - **Dimensions:** 7.48 x 2.95 x 0.68 in
  - **Weight**
    - **Modem: 6.3 oz.**
    - **Antenna: 8.8 oz.**



Acknowledgements

- Dr. van Graas (sponsor and advising)
- Jamie Edwards (brumby pilot)
- Sean Calhoun (controls and hardware)
- Jared Kresge (hardware and programming)
- Massimo Crisci (hardware and programming)
- Andrey Soloviev (frequency domain analysis)

Questions